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Study on Corrosion Performance and Microstructure of Sinter Hardened Artifacts, being Subjected to Various Finishing Including Zn Plating, Zn-Ni Plating, and Coating by Zn Rich Flake Compositions.

ABSTRACT

Sinter hardening (SH) is known as cost-efficient processing routine while combining both thermal consolidation of the parts from powder metal (PM) steels with its hardening in order to get increased hardness and strength. However, it is quite frequently needed to provide adequate corrosion protection for a range of applications due to their fabrication conditions and service environment.

With this regard, various surface finishing that includes separately applied Zn plating as well as Zn-Ni plating and Zn Rich Flake (ZRF) coatings, being put on artifacts from sinter hardened PM steels, resulted into forming of protective layers with distinguished mechanism of corrosion protection. Comparative study on obtained corrosion test outputs and microstructure analysis is presented and discussed.

INTRODUCTION.

Typical corrosion degradation of metals and alloys, except probably some corrosion occurrences (e.g. sulphidation) is an electrochemical process in which the metal reacts with its environment to form an oxide or other compound.[1] The National Association of Corrosion Engineers (NACE) International in its study [2] estimates the global cost of corrosion to be US$2.5 trillion, equivalent to roughly 3.4% of the global Gross Domestic Product (GDP). With regard to the magnitude of the current influence of corrosion onto the U.S. economics, the direct cost of metal loss in corrosion is $276 billion on an annual basis that represents approximately 3.1% of the U.S. GDP. [2-3] In an effort to limit the impact of corrosion, zinc-based surface protection had been established as one of the most commercially available processing techniques for steel parts finishing. Zinc (Zn) metal is quite abundant element in Earth's crust (≈ 0.0075%), and therefore is inexpensive technological material. Also, Zn has relatively low melting point (419.5°C) as well as a low boiling point (907°C).[4] There are many types of putting Zn for protection of underlying metal surfaces, which can be roughly segmented by chemical content between pure Zn and alloyed systems like Zn-Ni, Zn-Al, Zn-Co, Zn-Fe, and Zn composites.[5] In general, a broad utilization of Zn-based materials and processing techniques is occurred mainly because of zinc's unique electrochemical characteristics.[6] Thus, as the working environment operates in the presence of moisture and/or in combination with sulfur and or chloride ions, i.e. creates electrolyte medium, an electrochemical (galvanic) corrosion process takes place by forming an electrochemical cell between Zn protective surface layer, electrolyte and ferrous substrate. [6-7] All four elements such as anode, cathode, electrolyte plus return current path are necessary for an electrochemical corrosion to happen.[1, 7] Removing of any one of those elements will inhibits the flow of electrochemical current, and the galvanic corrosion process will not occur. Substituting of a different metal for an anode or cathode may cause the direction of the ions and electrons flow (i.e. electric current) to reverse, resulting in a switch of the electrode, being